U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT 76-115-425
H F E INC.
FT. COLLINS, COLORADO

SEPTEMBER 1977

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) in the Ft. Collins, Colorado, plant of H F E, Inc. Environmental sampling was done during a variety of activities required to manufacture farm machinery in February, 1977, for paint solvents, dust, welding fumes, and carbon monoxide; and in May, 1977, for carbon monoxide. A comparison of the results of that sampling with recommended criteria presented in Section IV C of this report, indicates that all employees in this plant are potentially exposed to toxic concentrations of one or more of these substances. This determination is consistant with employees' responses to non-directed medical questionnaires. It is further concluded that continued exposure could result in chronic illness to some employees. It is recommended that (1) carbon monoxide emissions be reduced by changes in the fork lift equipment, (2) local exhaust ventilation be installed for welders, (3) local exhaust ventilation be improved at the paint spray booth, (4) reevaluation of environmental contaminant levels follow adoption of controls, and (5) periodic monitoring for carbon monoxide, dust and solvents be conducted.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

a) H F E, Inc.
b) U.S. Department of Labor - Region VIII
c) NIOSH - Region VIII

For the purpose of informing the approximately forty "affected employees" the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health received such a request from an authorized representative of management H F E, Inc., regarding employee exposure to welding fumes, paint spray and fork lift exhaust.

IV. HEALTH HAZARD EVALUATION

A. Process Description

H F E, Inc. manufactures farm equipment used primarily in the sugar beet industry. The plant can be organized into three departments: the machine shop, the welding department, and the assembly area. All operations except spray painting are housed in one large open area with no partitions other than a small enclosure in the center which houses a restroom and a tool and die shop.

Steel stock is brought into the machine shop where it is sawed, flame cut, sheared or machined into proper size and shape by the approximately fifteen people in this area. The one saw and two milling machines use small quantities of straight chain cutting oils. Some plastic barriers and curtains are used to prevent oil mist spray onto workers and protect against metal fragments. The greatest potential problem from this cutting oil is dermatitis since this type of oil contains neither nitrites nor amines.

As parts come from the machine shop they go to the welding department where they are arc welded to form subassemblies. The parts being welded here are mild steel, so the principle contaminant is iron oxide fume although some of the welding wire is copper coated. Of the five welders, only one has any type of local exhaust ventilation. Some canvas barriers, approximately six feet high, are placed to prevent flash burn to other workers, but these serve also to reduce any general ventilation in this area. After a period of time, however, the haze that develops in this area from welding is spread throughout the plant.

The third department in this plant is the assembly area which includes spray painting. Most exterior parts are spray painted prior to combination with wheels, drive trains, and other subassemblies to produce the finished piece of machinery. Most of the spray painting is done in a room adjacent to the main plant. The pieces to be sprayed are hung from an overhead track, rolled in front of a large dry spray booth where they are sprayed, and then rolled back into the main part of the plant after a short drying period. Occasionally, large pieces will be sprayed outside. There is one full-time "inside" and one part-time "outside" painter. The vehicle for the paint pigment is a mixture of toluene, xylene and aliphatic petroleum naphtha. While painting, both painters usually wear half mask respirator, coveralls or long sleeve clothing, hat and gloves. Final product assembly is primarily a mechnical function, although occasionally touch-up painting is needed. This is, however, a small exposure.

In addition to the environmental contaminants created in the processes already mentioned, a potential exists for the build-up of carbon monoxide from fork lift trucks. During the time of this survey two trucks, one gasoline and one propane, were operating in essentially all areas of the plant.

One other operation was being performed during this survey, that being sandblasting of machinery outside the plant. According to management, this was a one time occurrence lasting two days, not to be repeated. Silica sand was being used, and the operator was wearing a full body suit including hood.

B. Evaluation Design

On January 31, 1977, a walk-through survey was conducted of the plant to develop a sampling strategy. During this walk-through pertinent data was obtained from company representatives regarding materials and processes. Employees were interviewed regarding work and smoking histories, physical complaints, and medical background with the use of a non-directed questionnaire.

On February 1 and 2, personal breathing zone samples were taken for welding fume, iron oxide, copper, paint solvents (toluene, xylene, and petroleum naphtha), and total dust. The distinction between welding fume and dust is chiefly one of source and is difficult to make in this situation. General area air samples were taken for carbon monoxide. Information was collected regarding work practices, controls and ventilation.

Iron oxide, copper fume and total dust samples were taken according to procedures outlined in NIOSH Sampling Data Sheets #25, #15 and #29, respectively.[1] Deviations from these procedures were an increase in flow rate from 1.5 to 2.0 liters per minute (lpm) and the collection of two consecutive 4-hour samples rather than one 8-hour sample on most workers. Some welding fume samples were taken inside the welding hood using specially adapted hoods provided with sampling ports. Analysis for copper and iron oxide was done according to procedures outlined by NIOSH.[9] Total dust was determined gravimetrically.

Solvent vapors were sampled by charcoal tube according to NIOSH Sampling Data Sheet #6.[1] Samples were taken at a flow rate of 0.1 lpm and two consecutive 4-hour samples were taken in most cases. Analysis was by procedures outlined by NIOSH.[9]

Carbon monoxide measurements were taken during the February survey with certified length-of-stain detector rubes. Samples were taken at various times during the day and at various locations throughout the plant at the discretion of the industrial hygienist. On May 17, 1977, a second visit to the plant was made to more accurately determine carbon monoxide levels using a direct reading carbon monoxide analyzer. Again readings were taken at various times and locations at the discretion of the industrial hygienist.

A 16-point air velocity traverse was made at the filter face of the paint spray booth and measurements were taken in the spray area with a velometer. Additional ventilation measurements were taken at the only welding exhaust hood.

C. Evaluation Criteria

Listed below are occupational exposure criteria recommended by NIOSH, the American Conference of Governmental Industrial Hygienists (ACGIH), and the OSHA eight-hour time-weighted average standards for the various contaminants measured at H F E. The TLV for petroleum naphtha is based on an equation taken from Appendix B of the ACGIH booklet,[5] and assumes that this mixture of hydrocarbons has an average boiling point between that of its two basic components, toluene and xylene and that the balance of the hydrocarbons in the mixture is aliphatic.

Contaminant	NIOSH Recommendation[2-4]	ACGIH TLV[5]	OSHA Standard[6]
Toluene	100 ppm	100 ppm	200 ppm
Xylene	100 ppm	100 ppm	100 ppm
Petroleum Naphtha	NA*	300 ppm	500 ppm
Carbon Monoxide	35 ppm	50 ppm	50 ppm
Welding Fume	NA	5 mg/M^3	NA
Iron Oxide	NA	5 mg/M^3	10 mg/M^3
Copper Fume	NA	0.2 mg/M^3	0.1 mg/M^3
Total dust	NA	10 mg/M^3	15 mg/M^3

*Indicates no recommendation for this substance.

All employees except the painters are exposed to a combination of all substances except toluene, xylene, and petroleum naphtha. It should be noted that welding fume is indistinguishable analytically from total dust, although the primary source of airborne particulate in this plant is the welding, either directly or from redistribution of settled welding dust by fork lift trucks and other activities. Therefore, the use of a 5 mg/M^3 criteria for dust would seem most appropriate. This assumption is reinforced by the results of employee interviews.

The painters are exposed to a combination of toluene, xylene, and petroleum naphtha. Since the toxicologic effects of these are similar, exposure to these substances should be considered as additive. If the sum of the fractions of exposure over criteria for each substance is greater than unity, there is an increased probability that continued exposure at those levels will result in adverse health effects to some employees.

Recommended ventilation criteria[7] for large paint-spray booths indicate a minimum face velocity of 100 to 150 feet per minute (fpm). For welding, a slot velocity of 1000 fpm for welding benches with clotted exhaust opposite the welder is recommended; a face velocity of 1500 fpm for tapered, flanged, portable exhaust is recommended.

D. Evaluation Results

Table I lists the results of all particulate sampling. Total particulate concentrations ranged from 1 to 30 mg/M^3 with an average of 6 mg/M^3. Iron oxide concentrations ranged from 0.6 to 22 mg/M^3 with an average of 2.5 mg/M^3. Copper fume ranged from non-detectable to 0.13 mg/M^3 with an average of 0.03 mg/M^3. Eight samples (seven on welders and one on the assembly foreman)

Ventilation measurements at the paint spray booth indicate a maximum velocity of 75 fpm at the face of the booth where the employee was spraying the workpiece. Air velocity at the face of the canopy hood used for welding exhaust was negligible (less than 50 fpm). Both systems were below minimum recommended standards.

Thirty-six employees were interviewed regarding work conditions and health. Several commented that conditions in the plant at the time of this survey in February were unusually good due to mild weather that allowed the doors and windows to be open more than usual. Thirteen of the 36 had no health complaints. Seven complained of sinus problems, difficulty breathing, or prolonged colds; nine complained of eye, nose, throat or other irritation felt to be caused by the work environment. Four workers stated that they frequently brought up sputum (two were cigarette smokers, one a pipe smoker). Other complaints included headaches, "nerves", and high blood pressure. Any of these symptoms could be caused or aggravated by acute exposure to dust, welding fumes and carbon monoxide.

E. Summary and Conclusions

For the information collected in this evaluation it is concluded that some employees of H F E were exposed to concentrations of solvents, dust, iron oxide and carbon monoxide at levels above recommended maximums. Differences in carbon monoxide levels between May, when the plant was completely open, and February, when doors and windows were only partly open, leads to the assumption that during cold weather, when the plant is completely closed, carbon monoxide levels would build up even higher. The same is presumed to be true of dust, fume and solvent levels.

V. RECOMMENDATIONS

1. The gasoline fork lift trucks are the primary source of carbon monoxide. These trucks should be replaced with electric models which emit no carbon monoxide, or with propane models which emit a small amount. If this is not possible, existing gas and propane trucks should be maintained to operate at the most efficient condition in order to produce as little carbon monoxide as possible.

2. Local exhaust ventilation should be installed for all the welders. It is important that such a system be properly designed and that its design include provisions for makeup air. The single exhaust hood now in the welding area is essentially useless. Canopy type hoods should not be used in situations such as this where the movement of air tends to draw the contaminant from the workpiece through the employee's breathing zone.

3. If reduction of fork lift emissions and local exhaust ventilation are effective on reducing carbon monoxide and welding fume concentrations, additional general plant ventilation will probably not be necessary. This would be advantageous, since general ventilation is expensive to install and maintain, especially the heating of makeup air in cold weather when the ventilation would be most necessary.

4. Ventilation at the paint spray booth should be improved. Currently, the maximum air velocity at the site of the sprayer is 75 fpm. The average velocity in this area should be 100-150 fpm, and this velocity should exist even if the outside doors are enclosed. The flow of parts should also be arranged so that the spray is always directed towards the booth; the employees should never stand between the part being sprayed and the booth. The sides and top of the booth should be brought out as far as possible without interfering with production.

5. Subsequent to the adoption of measures to control contaminants, a reevaluation should be conducted to determine their effects. Periodic monitoring should be conducted for carbon monoxide, dust, and solvents.

VI. REFERENCES

1. NIOSH Manual of Sampling Data Sheets, April, 1976, NIOSH.

2. Criteria for a Recommended Standard, Occupational Exposure to Toluene, 1973, NIOSH.

3. Criteria for a Recommended Standard, Occupational Exposure to Xylene, 1975, NIOSH.

4. Criteria for a Recommended Standard, Occupational Exposure to Carbon Monoxide, 1972, NIOSH.

5. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with intended changes for 1976, American Conference of Governmental Industrial Hygienists.

6. OSHA Safety and Health Standards, 29 CFR 1910, U.S. Dept. of Labor.

7. Industrial Ventilation, A Manual of Recommended Practice, 13th Ed., 1974, American Conference of Governmental Industrial Hygienists.

8. Criteria for a Recommended Standard, Occupational Exposure to Crystalline Silica, 1974, NIOSH.

9. NIOSH Manual of Analytical Methods, 1974, NIOSH.

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TABLE 1

Results of Personal Breathing Zone Samples for Particulate

HFE, Incorporated
Fort Collins, Colorado
February 1 & 2, 1977

Location	Sample Number	Date	Time	CONCENTRATION mg/M^3 Total Particulate	Iron Oxide	Copper
Assembly Man	674	2/1	07:45-12:05	3.4	1.3	0.02
Assembly Man	679	2/1	12:06-03:10	6.5	1.0	0.01
Flame Cutter	690	2/1	07:45-12:04	5.1	2.2	0.02
Flame Cutter	651	2/1	12:05-02:30	8.7	1.5	0.01
Tool & Die Man #1	670	2/1	07:55-11:58	7.6	2.0	0.02
Tool & Die Man #1	701	2/1	11:58-03:20	9.4	2.3	0.02
Machinist	675	2/1	07:55-12:01	4.6	1.2	0.02
Machinist	698	2/1	12:01-03:00	5.3	1.2	0.01
Fork Lift Operator	661	2/1	07:48-11:50	5.5	2.2	0.04
Fork Lift Operator	728	2/1	11:50-03:00	4.4	1.9	0.03
Welder, Machine Shop	671	2/1	07:53-12:11	3.4	1.3	0.03
Welder, Machine Shop	678	2/1	12:12-03:10	29.7	22.1	0.01
Shipping & Receiving	665	2/1	07:50-02:45	2.5	1.0	0.01
Assembly Foreman	687	2/1	07:52-12:06	5.9	1.6	0.03
Assembly Foreman	666	2/1	12:06-03:15	9.7	2.4	0.01
Fork Lift Operator	697	2/1	07:47-12:07	1.0	0.9	0.01
Fork Lift Operator	720	2/1	12:07-03:15	3.8	1.1	0.01
Welder #1	652	2/1	07:40-11:55	7.4	3.2	0.07
Welder #1	667	2/1	11:55-03:10	6.4	3.0	0.06
Welder #2*	664	2/1	07:30-11:55	4.4	2.2	0.04
Welder #2	673	2/1	11:55-03:00	9.3	6.0	0.06
Tool & Die Man #2	676	2/1	08:00-11:57	3.6	1.5	0.02
Tool & Die Man #2	685	2/1	11:57-03:20	2.7	1.0	0.02
Punch Press & Operator #1	715	2/1	08:03-03:15	3.3	1.4	0.01
Punch Press & Operator #2	658	2/1	08:04-11:58	4.0	1.6	0.02
Punch Press & Operator #2	736	2/1	11:59-03:15	2.4	1.1	0.01
Machinist	710	2/1	08:01-12:00	3.0	0.8	0.01
Machinist	748	2/1	12:00-03:15	6.8	0.9	0.01

*Samples taken inside welding helmet

TABLE 1 (CONT'D)

Results of Personal Breathing Zone Samples for Particulate

Location	Sample Number	Date	Time	CONCENTRATION mg/M^3 Total Particulate	Iron Oxide	Copper
Tool & Die Man #3	656	2/1	08:00-12:00	3. 3.9	1.6	0.02
Tool & Die Man #3	663	2/1	12:00-03:20	2.6	1.1	0.01
Foreman	681	2/1	07:57-12:08	3.4	1.4	0.02
Foreman	726	2/1	12:10-03:00	2.0	0.7	<0.01
Welder #3*	660	2/1	07:35-11:45	9.5	5.1	0.05
Welder #3*	725	2/1	11:45-03:00	3.7	2.6	0.03
Fork Lift Operator	638	2/2	07:40-11:58	3.3	1.1	0.01
Fork Lift Operator	570	2/2	11:52-03:15	4.6	1.2	0.01
Welder #4	621	2/2	11:23-03:15	15.1	8.1	0.13
Welder #3	625	2/2	07:30-11:37	5.5	2.5	0.04
Welder #3	566	2/2	11:37-03:15	3.3	1.6	0.02
Welder #2	578	2/2	07:35-11:47	11.5	7.6	0.07
Welder #2	556	2/2	11:47-03:15	12.9	8.5	0.07
Assembly Man	582	2/2	07:40-11:40	5.5	1.5	0.02
Assembly Man	580	2/2	11:40-02:55	5.0	3.1	0.01
Welder #1	637	2/2	07:35-11:43	7.1	3.2	0.05
Welder #1	577	2/2	11:43-03:00	>8.9	>2.1	>0.03
Assembly Man	573	2/2	11:35-03:05	3.2	1.4	<0.01
Welder, Machine Shop	555	2/2	07:35-11:15	4.6	1.8	0.02
Welder, Machine Shop	640	2/2	11:15-03:05	2.1	0.8	<0.01
Flame Cutter	583	2/2	07:52-11:20	5.0	2.2	0.02
Flame Cutter	585	2/2	11:20-03:05	3.9	1.8	0.02
Saw Operator	608	2/2	07:52-11:17	5.0	1.2	0.02
Saw Operator	589	2/2	11:18-03:05	4.3	0.6	<0.01
Foreman	554	2/2	07:50-11:25	5.1	1.6	0.01
Foreman	588	2/2	11:25-03:05	3.0	1.2	0.01
Milling Machine Operator	620	2/2	07:48-11:15	4.2	1.1	0.02
Milling Machine Operator	572	2/2	11:15-03:05	2.9	0.9	0.01

*Samples taken inside welding helmet

TABLE II
Results of Personal Breathing Zone Samples for Paint Solvent
HFE, Inc.
Ft. Collins, Colorado
Feb. 1 & 2, 1977

Location	Day	Time	Concentration (PPM) Toluene	Xylene	Petroleum Naphtha
Inside Spray Painter	2/1	08:10-12:05	75	41	5*
Inside Spray Painter	2/1	12:05-03:00	47	37	4
Assembly Man # 1	2/1	08:00-12:10	10	5	1
Assembly Man # 1	2/1	12:10-03:20	6	3	< 0.2
Assembly Man # 2	2/1	08:00-12:10	10	6	1
Assembly Man # 2	2/1	12:10-03:00	32	4	< 0.2
Outside Spray Painter	2/1	12:00-02:30	37	21	2
Inside Spray Painter	2/2	07:55-10:30	43	30	3
Inside Spray Painter	2/2	10:30-12:50	280	17	3
Inside Spray Painter	2/2	12:50-02:55	91	70	7
Outside Spray Painter	2/2	10:30-12:55	20	13	3
Outside Spray Painter	2/2	12:55-02:50	32	25	3

* Petroleum Naphtha concentrations based on assumption that average molecular weight for that material was approximately 150.